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R. M. Pratt

Citrus Insect Control For March 1955

R. B. Johnson

W. L. THOMPSON,
R. M. PRATT
R. B. JOHNSON*
Florida Citrus Experiment Station, Lake Alfred

W. L. Thompson

New growth is advancing rapidly and it now appears that the peak of spring flush will be reached about the middle of March. Although growth started early, it has been retarded by cool weather and it appears that the peak of leaf growth and the peak of bloom will occur at about the same time. Some groves will be ready for the post-bloom spray application in the last week in March.

There is every indication that six-spotted mite infestations will be severe this spring. Infestations on water sprouts and old leaves in January and February have been more numerous than at any time in the past five years. These mites will start moving on to the new growth very soon and considerable leaf distortion and defoliation can be expected. The peak of infestations will be reached about the middle of May.

Purple mite infestations will be more severe than in any year since 1951, according to present indications. However, if abundant spring rains occur, the infestations will be lighter than now expected.

Red scale populations are low and infestations are expected to remain light through the post-bloom period. There will be a peak of hatching in March but activity is not expected to reach a high level.

Purple scale populations are moderately high and activity is expected to increase through March. A hatch has begun which will reach its peak early in April. The application of a post-bloom scalicide will be advisable in many groves.

Aphid infestations are expected to be about average this season. Mealybugs will probably be more abundant than usual.

SPRAY PROGRAM

Judging from the weather outlook and the present stage of growth, it seems probable that very few groves will be far enough advanced in growth to spray before April. Also, unlike last year when the blooming period was irregular and spread over a couple of months, the start of the post-bloom period will come all at once. In the meantime, spraying should be held to a minimum to avoid injury to succulent foliage from spray materials and mechanical injury from the force of the spray.

The post-bloom spray program may be more or less complicated this year because the probability of infestations of six-spotted mite and purple mite along with purple scale. To avoid the necessity of respraying groves within a short period of time, an inspection of each grove should be made to determine whether it should be treated for the control of six-spotted mites, mealybugs, and purple scale in addition to purple mites, rust mites and melanose. Six-spotted mite infestations can develop very rapidly on the under surfaces of young leaves and cause a heavy leaf drop. Purple and red scale are now settling on young growth as well as old leaves but they can be easily detected on young growth.

During late March a few groves may be far enough advanced for the post-bloom spray. Where large acreages are to be covered or in groves where heavy infestations of mites or scale exist, spray operations can be started when 90 percent of the petals have dropped without too much danger of foliage injury.

In many cases the grower will want to apply combination sprays containing one or more of the following materials: compounds of copper, zinc and manganese as well as borax, sulfur, a miticide and a scalicide. An arsenic compound may also be desired on grapefruit. Where oil is to be used for either purple mite, six-spotted mite or scale control, the combination of materials is limited. On grapefruit a combination of oil, copper and arsenate of lead is practical, but care should be taken to see that the mixture does not flocculate. On oranges, it is not advisable to use more than one of the metals in an oil emulsion because of danger of marking fruit and reducing the efficiency of the oil as a scalicide. Oil in any form should not be used during dry weather because it may cause young fruit to drop. Where more than one of the metals such as copper, zinc and manganese are needed, it is advisable to use parathion for the scalicide and either ovex or aramite for the control of purple mite and six-spoted mite.

As stated in the first paragraph, spraying should be kept to a minimum during the pre-bloom period while the growth is very succulent, but where control is necessary, the following programs are suggested.

Scale Control: Both oil and parathion are likely to injure very succulent foliage, but oil has been less injurious than parathion on growth three to six inches long. If scale control is necessary, use oil at 1.3% except on Valencias with mature fruit that will have to be colored in the coloring room. Oil does not effect solids in mature fruit.

Mealybugs are controlled with parathion (15%) at 1.66 pounds per 100 gallons. Where control is necessary this month delay the application until the new growth has matured so the parathion will not injure the foliage.

Purple Mite Control: Aramite and ovex are the safest materials while the growth is succulent. Wettable sulfur can be combined with these materials without adding to danger of injury. If oil emulsion is used, apply it 0.7% actual oil which is less injurious than 1.3%.

Six-spotted mites are controlled with the same materials used for purple mite control but a very thorough coverage of the under surfaces of leaves is necessary.

Rust mites should be controlled with either wettable sulfur or dusting sulfur. Lime-sulfur is toxic to succulent foliage.

Aphids may be a problem in some young groves, especially those hurt

(Continued on page 9)

* Written February 24, 1955. Reports of surveys by Harold Holtsberg, Cocoa; J. W. Davis, Tavares; E. G. Townsend, Tampa; J. B. Weeks, Avon Park; and T. B. Hallam, Lake Alfred.

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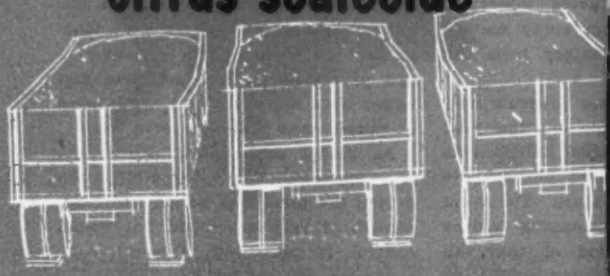

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Effect Of Method Of Timing Nitrogen Fertilizers On Yield And Quality Oranges

WALTER REUTHER
PRINCIPAL HORTICULTURIST
AND
PAUL F. SMITH
PLANT PATHOLOGIST
Horticultural Crops Research Branch
Agricultural Research Service
U. S. Department of Agriculture

Most growers recognize the dominant role that nitrogen fertilization plays in maintaining good vigor and high productivity of Florida citrus groves. Recent studies have shed some light on the effect of rate of nitrogen fertilization on fruit quality (11), but there still is a vital need for more sound experimental data indicating the relation of rate of nitrogen fertilization to yield. Moreover, there are almost no published experimental results indicating the effect of the timing of nitrogen applications on yield or quality of fruit. It is the purpose of this report to summarize data from several experiments bearing on timing. A few incidental data concerned with the effect of rate of nitrogen fertilization will be summarized also. It is hoped that these data, together with those of other workers, will be of some value to those responsible for the formulation of fertilizer programs.

Parson Brown Experiment

A 9-acre block near Doctor Phillips, Florida of large, uniform Parson Brown orange trees on Rough lemon stock planted 60 to the acre was chosen for this experiment. The trees were approximately 21 years of age when differential treatment were started in the fall of 1947. The soil was reasonably uniform and typical of the very sandy phase of the Lakeland series which supports pine and "black-jack" oak in the virgin state.

A random-block design was used for comparing 6 treatments with five replications, a total of 30 plots. Each plot consisted of 8 record trees (2 rows of 4 each) completely surrounded by non-record of "buffer" trees. Fertilizers were spread by machine in the three middles encompassing the two rows of record trees. The fertilizer for each plot was applied as uniformly as possible to the area outlined by the trunk-row lines of the surrounding buffer trees. Hence, most buffer trees were subjected to one treatment on one side and to another on the other side.

The treatment compared are outlined in table 1. In this study, the fertilizer year for a given crop is considered to begin with the fall application **before** the bloom producing that crop. Note that timing of nitrogen was the only variable in treatments A, B, and F—the timing and rate of other fertilizer elements were held constant. In treatments C, D and E the timing or rate of elements other than nitrogen was also varied.

The annual dosages in pounds per tree for all treatments except D and E were as follows: N=2.4; P_2O_5= 3.6; K_2O=4.8; MgO= 1.8; MnO= 0.6; CuO= 0.3 and B_2O_3=0.06. Treatments D and E received the same nitrogen rate as all the others, but only half as much of elements other than nitrogen. In the 1947-48 season, the dosage used was about 83% of the rates just listed for all elements. Also, in the 1947-48 season, treatments B and

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D received 2/3 of the annual dosage of nitrogen in the fall, 1/6 in the spring and 1/6 in the summer.

The method of timing and rate used in treatment A were the standard practices commonly used in 1948. The rate of fertilization with the various elements has now been revised, but the use of three applications of nitrogen-containing fertilizer per year is still common practice. Present recommendations (10) would suggest about 4 lbs. of N per tree for each year for these large trees having a 10 box (16 bu.) capacity.

The data in table 2 show that the method of timing nitrogen had no significant effect on yield during two seasons. Applying a fixed annual dosage of nitrogen in 1, 3 or 6 applications (treatments B, A and F, respectively) had no effect on yield during the experimental period. Also, it made little difference in yield whether nitrogen was applied in three equal doses in the conventional manner (treatment A) or one large dose in the fall (treatment B, D and E) or in the spring (treatment C). The rate and timing of elements other than nitrogen likewise had no significant effect on yield.

Analysis of fruit samples (random sizes) obtained in mid-October from the 1948 crop (data not presented) indicated that there was no significant effect of treatment on any of the quality factors measured, but the total soluble solids level in fruit from all treatments was very low for the Parson Brown variety. The data in table 3 on size, rind thickness and juice composition of samples (24 fruits per plot) obtained from the 1949 crop show substantially the same trends as obtained in 1948, but there was a suggestion that treatment C tended to delay maturity (solids-acid ratio) and "color break" slightly—perhaps about 1 week to 10 days. Also, the vitamin C content of the fruit from treatment F was slightly but distinctly lower than that of other treatments.

Table 1. Schedule of application of nitrogen and other fertilizer elements to Parson Brown plots for 1948-49 season

Time of application	Fertilizer element	Fraction of annual dosage applied for various treatments					
		A	B	C	D	E	F
Fall (Oct. 15-Nov. 15)	Nitrogen	1/3	All	0	All	All	1/6**
	Others	1/3	1/3	1/3	0	1**	1/3
Spring (Feb. 15-March 15)	Nitrogen	1/3	0	All	0	0	1/6
	Others	1/3	1/3	1/3	All	1*	1/3
Summer (May 15-June 15)	Nitrogen	1/3	0	0	0	0	1/6
	Others	1/3	1/3	1/3	0	0	1/3

* All N and K2O applied in fall; all other elements applied in spring.
** Nitrogen applied approximately every two months; hence an amount equal to 1/6 of the annual dosage was also applied in December, April and August.

Table 2. Effect of time of application of nitrogen and other fertilizer elements on yield of early orange, Parson Brown Experiment

Treatment* and statistical indices**	No. annual applications, 1948-49 season		Yield (boxes per tree)		
	Nitrogen	Other elements	1947***	1948	1949
A	3	3	11.3	7.9	10.4
B	1 (fall)	3	11.4	8.2	10.2
C	1 (spring)	3	11.8	7.6	10.2
D	1 (fall)	1 (spring)	11.9	8.1	11.3
E	1 (fall)	2	11.3	8.0	11.5
F	6	3	11.5	7.9	10.1
Treatment F value			0.35	0.26	1.53
Coef. variability, %			8.3	11.6	10.6

* See table 1.
** The F value required for significance at 0.05- 2.71. The coefficient of variability- error x 100/grand mean.
*** Differential treatments were started Nov. 13, 1947, when the 1947 crop was already mature. Hence 1947 yields (not completed until Jan. 13, 1948) are essentially uniformity data. Harvests of the 1948 and 1949 crops were compared Dec. 1, 1948, and Nov. 28, 1949.

The 1949 leaf analysis data in table 4 show that the various treatments had little effect on leaf composition except that reducing the rate of potash fertilization (treatments D and E) reduced the potash content of the leaves appreciably. A similar effect was indicated by the 1948 leaf analysis data (not presented).

Hamlin Experiment

A 6-acre block of young bearing Hamlin oranges on Rough lemon stock planted in 1941 in a location near Minneola, Florida, was used for a second nitrogen experiment. The soil was typical of the very sandy, deep phase of the Lakeland series found in the rolling hills of this section. The depth to clay exceeded 8 feet in the entire plot area.

Table 3. Effect of time of application of nitrogen and other fertilizer elements on same fruit qualities of early oranges harvested Nov. 16, 1949, Parson Brown Experiment

Treatment* and statistical index**	Weight per fruit	Rind thickness	Juice content (vol./wt.)	Composition of juice			
				Total soluble solids	Citric acid	Solids / acid ratio	Vit. C per 100 ml.
	gm.	mm.	%	%	%		mg.
A	174	4.0	52.9	9.2	0.72	12.8	41
B	165	3.9	53.7	9.2	0.72	12.8	41
C	166	3.9	52.5	9.3	0.80	11.6	43
D	162	3.9	53.5	9.1	0.72	12.6	43
E	162	3.9	53.7	9.0	0.70	12.9	41
F	176	4.0	52.7	9.0	0.74	12.2	40
L.S.D. at 05	N.S.	N.S.	N.S.	N.S.	0.06	0.9	1

* See table 1. Each value presented above is the mean of five plats for each treatment.
** L.S.D. at .05 - least difference required for significance between any two means with odds of 19 to 1.

A confounded factorial design (3) was used to compare nitrogen from 3 sources at 2 rates and with 2 methods of timing. Each of the 12 treatments were replicated 3 times. A plot consisted of 4 trees in a line separated by buffer trees. The nitrogen sources compared were ammonium nitrate, a synthetic urea-formaldehyde source and a mixture of these two. At the outset of the experiment, the synthetic urea-formaldehyde was thought to be rather insoluble and slowly available somewhat like a natural organic material such as castor pomace. However, the tree behavior, yield data and leaf analysis all tended to indicate that this synthetic nitrogen material in this soil behaved as if a portion of it were rather quickly available and the rest simply never broke down to an available form. The data presented herein are not concerned with an evaluation of these three nitrogen sources, but relate to the effects of rate and timing of nitrogen. The rate and timing trends were substantially the same for all three sources. Hence, the effects of the three nitrogen sources are polled in the data in tables 5, 6 and 7, and each value presented represents the mean for 18 plots.

Weighed amounts of the nitrogen materials were applied by hand as uniformly as possible to the area, 25 x 100 feet, occupied by the four tree plots. Fertilizer elements other than nitrogen were applied as a mixture by machine to all trees in the experimental block in three applications per year. In the 1949-50 season the annual dosages (pounds per tree) were P205, 1.0; K20, 1.0; Mn0, 0.1 Cu0, 0.16 and B203. 0.03. Thus the low nitrogen plots received a fertilizer with N-P205xK20 approximating a 3-4-10 ratio and the medium nitrogen plots about a 6-4-10 ratio. Dolomitic limestones was applied annually

to all plots at the rate of about 1000 lbs. per acre.

In table 5, two rates of nitrogen applications, referred to as low and medium, were compared. Rates in a range thought to limit yield were deliberately chosen so that any improvement in efficiency of utilization would show up clearly. In 1949, these rates were 3/4 and 1½ lbs. of N per tree per year. In 1949 and 1950, when the trees were respectively, 8 and 9 years of age, the yield data (not presented) indicated that even 1½ lbs. of N from urea-formaldehyde was limiting yield as compared to 1½ lbs. from ammonium nitrate.

The yield data in table 5 show that the medium rate of nitrogen fertilization increased yield about 1/3 as compared to the low rate when the 3 years are averaged. Applying the annual nitrogen dosage in one application in the fall significantly increased yield in two of the three test years studied when compared with splitting this dosage into three applications.

The data in table 6 show that the rates and methods of timing nitrogen had only a slight effect on fruit quality when samples of random sizes were compared. The only consistent effect of nitrogen rate was on juiciness of the fruit. The juice content of the low-nitrogen fruit was consistently somewhat lower than that of the medium-nitrogen fruit. There were no important consistent effects of nitrogen level on juice composition or rind color during the three seasons sampled.

The application of the entire annual nitrogen dosage in the fall consistently increased juiciness of the fruit somewhat as compared with the conventional three applications per year. In addition, maturity (solids-acid ratio) of the fruit receiving one application a year was advanced about 1 week as compared with that receiving 3 applications a year. This was associated with a parallel slight hastening of "color break". This slight hastening of maturity was due more to a reduction in acid than to an increase in solids content of the juice. In general, the solids-acid ratio of this variety increases from 0.4 to 0.6 unit per week in October and November (8). There were no consistent effects of treatment on vitamin C content of the juice.

The leaf analysis data in table 7 show that the medium nitrogen level was associated with a somewhat higher level on nitrogen in the leaves than the low nitrogen level, as was expected. This increased nitrogen content was associated with a slight reduction in potash content of the foliage. The timing of nitrogen application did not affect, appreciably, the composition of 5-month-old spring leaves from non-fruiting terminals. However, leaf samples taken at other times during the year (data not presented) did show a significant effect of timing on the nitrogen content of leaves. For example, the nitrogen content of 11-month-old spring leaves collected just before bloom was higher in plots receiving all the nitrogen in the fall than in those receiving three applications per year.

Table 4. Effect of time of application of nitrogen and other fertilizer elements on composition of spring leaves collected July 27, 1949, Parson Brown Experiment

Treatment* and statistical index**	Mean wt. of leaves, (mg.)	Mean percent in dry matter				
		N	P	K	Ca	Mg
A	308	2.51	0.13	2.09	3.91	0.30
B	314	2.42	0.14	1.84	4.21	0.31
C	314	2.43	0.13	1.94	4.29	0.34
D	324	2.39	0.12	1.61	4.43	0.32
E	331	2.38	0.12	1.62	4.53	0.33
F	312	2.45	0.13	1.90	4.15	0.32
L.S.D. at .05	N.S.	N.S.	N.S.	0.18	0.32	N.S.

* See table 1.
** L.S.D. at .05- least difference required for significance between any two means with odds of 19 to 1.

Table 5. Effect of rate and method of timing nitrogen on yield of young early oranges, Hamlin Experiment

Nitrogen treatment and statistical indices*	Yield (mean boxes per tree)			
	1947**	1948	1949	1950
Annual rates* **		1.55	0.69	2.62
Low	0.73	1.80	1.18	3.28
Medium	0.59			
Method of timing		1.89	0.91	3.32
All in fall	0.66	1.45	0.90	2.70
Three applications	0.67			
L.S.D. at .05	N.S.	0.32	0.20	0.14
L.S.D. at .01	N.S.	0.45	0.27	0.19

* L.S.D.- least difference required for significance between the paired means with the odds indicated. Each valve represents the mean of 19 plots. N.S. indicates the effect of treatment was not significant.
** Differential treatments were started Nov. 14, 1947, when the 1947 crop was already mature. Hence, the 1947 yields (harvested Dec. 18) are essentially uniformity data. The other three crops were all harvested near the middle of November.
*** Low- ½ lb. and medium- 1 lb. N. per tree. Beginning in October, 1949 the rates were stepped up to 3/4 and 1½ lbs., respectively. Hence, the 1950 yield were subject to influence by this increased dosage.

Valencia Experiment

A third nitrogen-timing-and-rate experiment, started in 1949, is now in progress in a block of young Valencia orange trees on Rough lemon stock located on a hilltop of Eustis fine sand near Monteverde. In this experiment, splitting the annual dosage of nitrogen into 3 equal applications per year is compared with applying all the nitrogen in one dose in October and in one dose in February or March. Two annual rates of nitrogen fertilization—normal and high, are compared. The details will be presented in a later report, but some general trends are summarized here.

Yield data obtained during the first four record seasons indicated that there was no consistent significant effect of timing on yield. The average yield for the four-year period indicated that the three timing treatments all produced very nearly the same amount of fruit during the period of differential treatment. In 1951, when the trees were 9 years old, the high nitrogen rate (2.8 lbs. N per tree) produced about 20% more fruit than the normal rate (1.4 lbs. N per tree). In the subsequent test years, there was no significant effect of nitrogen rate on yield, but the nitrogen rates were increased to 1.5 and 3.0 lbs. in the fall of 1951 and to 1.8 and 3.6 in 1952 and subsequently. Neither the method of timing nor the rate of application of nitrogen has had any consistent effect on Valencia fruit quality large enough to be of any practical significance.

Discussion

In the production of citrus in Florida, efficiency of nitrogen use appears to be rather low. Commonly between 0.10 and 0.14 lb. of nitrogen is removed per box (90 lbs.) of fruit harvested (14), while current recommendations (10) suggest the application of 0.4 lb. of nitrogen per box. In spite of the fact that fertilizer applications are confined very largely to the drier months, it has been commonly accepted that this low efficiency is due to the susceptibility of nitrogen to leaching out of our deep, sandy soils under the prevailing climatic conditions. In fact, lysimeter and related studies (1, 4 15) seem to support this theory. However, the data presented in this paper and some other recent evidence suggest that susceptibility to leaching may not be the

(Continued on page 12)

Citrus Vitamin P In Common Cold

Forty years ago, the Florida citrus industry was very small indeed. It was in an embryonic stage of development and the consumption of oranges and grapefruit in this country at that time was very limited, and of insignificant dietary importance. Only a few persons, here and there, ate citrus fruit as a part of their daily diet. No wonder that under these circumstances, the attempt made by a Floridia scientist to use citrus fruit for medical purposes was quite audacious and met with skepticism and, as a matter of fact, strong opposition on the part of his colleagues.

Dr. A. W. Giampietro, of Tampa and later of St. Augustine, had an inquisitive and searching mind. He was puzzled by the bitter taste of grapefruit and orange peel. He wondered if these fruits did not contain quinine or quinine-like substances. He remembered from his days as a boy in his native Naples, Italy, that some doctors recommended eating oranges and lemons when one had a cold.

Dr. Giampietro had no actual laboratory, so to speak, to work in. He transformed part of the kitchen into a laboratory, to the great annoyance of his wife. He started to extract orange and grapefruit, to purify them with various chemicals, and after many failures and errors, he succeeded in preparing a dry powder, yellowish-white, of a very bitter taste. He decided that it was a quinine or at least a quinine-like substance. He made no tests to prove its chemical nature, but began at once the treatment of persons affected with common cold and influenza with his "citrus quinine."

He was successful on a small scale, and claimed that many of the sufferers were relieved at once from their infections after having taken his "magic" remedy for a day or two. The medical profession resented this unorthodox therapy, a fact which was quite understandable and logical. Dr. Giampietro died before he was able to pursue his experiments to any satisfactory end. He left, however, a small supply of his "citrus quinine" which his wife, fortunately, kept intact.

The late J. Edgar Wall, at that time Postmaster of Tampa, met Dr. Giampietro on one or two occasions. The story of his discovery appealed to the imagination of Mr. Wall, who was always interested in any new development in his native state. After Giampietro's death, Mr. Wall communicated with his wife and she agreed to share with him the precious powder prepared by her late husband. She sent a small sample to Mr. Wall, hardly more than five grams of this "citrus quinine." In vain, Mr. Wall tried to interest the physicians and businessmen of Florida in his rediscovery of Dr. Giampietro's invention. Nobody was impressed by this powder. Quite by accident, Mr. Wall contacted me, while I was associated with Columbia University in New York, through his friend Walter Engle. He asked me to test this powder and to find out what its chemical nature was. Is it quinine? And if not, why did it have, as Dr. Giampietro claimed, medical properties? With some hesitation, I took this powder and analyzed it. It was, indeed, of a very bitter taste. But it was not quinine or any similar substance. It was vitamin P. That was the beginning of the investigation on citrus vitamin P at Florida Southern College. Mr. Wall, who was the chairman of the Board of Trustees, and Mr. Engle persuaded Dr. Spivey, President of the College to invite me to come to Lakeland. I came here intending to stay no more than two or three months. But as the work progressed and we were able to discover a practical and inexpensive method of isolating vitamin P from citrus

BORIS SOKOLOFF, M. D., PH. D.
DIRECTOR SOUTHERN BIO-RESEARCH LABORATORY
FLORIDA SOUTHERN COLLEGE

waste, I remained here for eight years.

During these years, in cooperation with more than 95 hospitals all over the country, the medical value of citrus vitamin P has been proved experimentally and clinically in various diseases where the small blood vessels are injured, such as radiation therapy, miscarriages, retinitis, tuberculous hemoptysis and various bleedings. Three years ago, Pasco Packing Company built the vitamin P plant at Dade City, which at present works day and night, producing the valuable vitamin P from citrus wastes.

Was Dr. Giampietro wrong in his claims that there is a factor in citrus fruit which has a therapeutic value in the common cold and influenza? For the eight years that I have been involved in the vitamin P investigation, I had no doubt about this matter. I was sure that he had made a mistake in judgement in this respect. True enough, no one associated with our project ever tried, never even thought of trying citrus vitamin P in common cold or influenza, for it was assumed that citrus bio-flavonoids have no anti-bacterial properties. No wonder that it was a great surprise to us when a few months ago, two New York physicians announced that citrus vitamin P relieves the symptoms of the common cold and influenza.

Dr. Morton Biskind, who was for a number of years on the staff of the American Medical Association, Council on Pharmacy, and Dr. William Coda Martin, came across their discovery quite by accident. They treated with citrus vitamin P, a patient who bled from the rectum. Besides his bleeding, this man had a high fever, a sore throat, and was coughing and sneezing. The picture was clearly that of influenza. The bleeding stopped at once, as it should have. But the fever also went down in 12 hours, after the patient had consumed large doses of this preparation, every three hours 300 milligrams. The next day, he was free of all symptoms. No sneezing, no coughing, no malaise. The doctors, baffled by this phenomenon, were inclined to consider this as a pure coincidence. However, they decided to treat other patients affected with common cold and influenza, with upper-respiratory infections in general, with citrus vitamine P. In a short time they collected data on sixty-nine patients. They were astonished by the dramatic results of this therapy, as they acknowledged in their report. In all cases, except three, the results were the same: the prompt relief from all the symptoms typical of these infections. Some times it took 12-15 hours, sometimes longer, 48-50 hours, to clear up the disease. In most of the cases, there was a profuse perspiration with fever dropping sharply after a few grams of this preparation was taken by the patients at the interval of every three hours.

They announced their findings to the medical profession by publishing their report in a leading medical journal, the Americal Journal for Digestive Diseases and Nutrition. By now, they have collected several hundred cases of common cold and influenza, and other upper-respiratory infections successfully treated with the citrus product. There were some failures, but hardly more than in five per cent of the total number of their cases.

Why should citrus vitamin P, which is of a flavonoid chemical nature, be effective in common cold and influenza? Vitamin P is not an antibiotic, it does not kill or destroy germs of these diseases. Drs. Biskind and Martin gave a scientifically sound explanation for the therapeutic activity of citrus bio-flavonoids. In bacterial or viral invasion of the mucous membrane of the throat, or mouth, or bronchii, they said, there is always an extensive inflammatory process which complicates the infection. The small blood vessels, the capillaries, are injured, protein-molecules penetrate through the wall of blood vessels into the tissue, and small areas of bleeding are present. Thus the tissues of the organism are defenseless, or almost defenseless, against the invading virus. Citrus vitamin P, they found, is an anti-inflammatory agent, which improves and corrects the functioning of the capillaries and subsequently minimizes the inflammation caused by viruses. Thus the action of the citrus product is indirect, yet efficient. It shortens the period of the infectious diseases, it prevents the spreading of virus invasion.

The findings of Biskind and Martin have already been confirmed by other physicians (Dr. Saelhof of Chicago, etc.) and the clinical work along these lines is being conducted on a large scale.

This accidental discovery might be of considerable help to the Florida citrus industry in general and citrus growers in particular. For fresh oranges and grapefruit are more rich in vitamin P than juice, and the consumption of fresh citrus fruit might find a new angle of promotion in health and disease.

The rediscovery of Dr. Giampietro's invention was made possible through the efforts of the late J. Edgar Wall, and it is a tribute to his memory.

CITRUS INSECT CONTROL
FOR MARCH, 1955

(Continued From Page 3)

by cold weather and thus late in putting out a growth. Nicotine sulfate at 1 pint per 100 gallons plus a spreader is effective. Wettable sulfur can be used as a spreader. Parathion or TEP are also effective but should be applied on a warm, calm day. Apply the spray as a mist and before the leaves are badly curled.

For more detailed information refer to the 1955 "Better Fruit Program" or consult the Citrus Experiment Station at Lake Alfred or Fort Pierce.

Florida has 42 species and subspecies of crayfish. This is more than any other state in the Union, according to Horton H. Cobbs, Jr., in his book, "The Crayfish of Florida," published by the University of Florida Press.

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"Spreading Decline" Of Citrus Continued

Investigations With Systemic Treatments

HARRY W. FORD
FLORIDA CITRUS EXPERIMENT STATION, LAKE ALFRED
AT MEETING OF FLORIDA STATE HORTICULTURAL SOCIETY

Systemic pesticides are non-phytotoxic chemicals which, when absorbed into the plant, cause the plant to be toxic, repellent or otherwise unsuitable as a host to organisms that seek to injure it. Thus the toxic action comes from within the plant without harming the tissues of the plant. It is readily apparent that a suitable systemic chemical would be of immeasurable value against the burrowing nematode if it would result in revitalizing Decline trees or preventing the attack of the nematode on healthy trees. For this reason, compounds are being screened on a large scale in an attempt to find something that may be toxic or inhibitory to the action of the burrowing nematode.

The use of systemic poisons is relatively new and most of the materials in use today were designed to kill insects that feed upon the foliage. A suitable systemic for Spreading Decline must possess the following basic characteristics: the compound must move down into the feeder roots in sufficiently high concentration and remain for a period of time; the material must be nontoxic to the tree but highly inhibitory to the nematode, and at the same time the chemical must be nontoxic to humans, at least in the form in which it may enter into or accumulate in the fruit.

Finding a suitable chemical will not be easy and the chances of success appear extremely small for the time being. Most compounds, including the new systemic compounds used to kill insects, are translocated to the top of the tree rather than down to the roots. Another large group of compounds must be eliminated because of known toxicity to both plant and humans. Previous work included 8-hydroxyquinoline sulfate, 8-hydroxyquinoline benzoate, and sulfanilomide in 1946, and numerous inorganic compounds in 1952.

The present approach to the problem consists of screening chemicals by injecting the materials into diseased trees which growers have made available for this study. Initial tests which include about 600 trees, consist of mixing the dry chemicals in a carbowax carrier and placing in holes drilled into the trees. The material is usually absorbed in about two weeks. Materials under test include anthelmintics, antibiotics, systemic insecticides, hormones, pesticides, inorganic and organic chemicals, and mixtures of materials. Any treatment that stimulates tree growth in the screening tests will be studied in greater detail and other methods of application tried.

The Hot Water Treatment Of Nematode Infested Nursery Stock

WRAY BIRCHFIELD
FLORIDA STATE PLANT BOARD, LAKE ALFRED
AT MEETING OF FLORIDA STATE HORTICULTURAL SOCIETY

The finding that citrus-nursery stock infested by the burrowing nematode has carried Spreading Decline has opened up a new aspect of the problem. The fact that ornamentals of various types were also infested has further complicated the problem. While infested nurseries were quarantined as found, it became very important that some method be found for treating nursery stock to free it from nematodes if at all possible. In all, 38 nurseries have been found infested and represent a large investment to the owners and we have undertaken investigations of the possibility of treating nursery stock to free it of burrowing nematodes so it may be safely used. Since citrus nursery stock is usually moved bare root, the problem is less difficult than the problem of handling potted or balled ornamentals. Work was started on citrus first.

The literature disclosed that hot water had been applied effectively against **Aphelenchoides fragarie** by Christie and Crossman (3, 4), and against **Tylenchus dipsaci** by Sherman (8), Chitwood (2), and Blanton and Chitwood (1). Sherman (9) reported the effective control of root knot of potatoes, but Thomas (12) reported that hot water was not practical for the control of the citrus nematode on seedlings. Feeling that the hot water represented the best possibility, work was commenced along this line.

Methods and Results

The objectives of this investigation

were to determine the thermal death point of the burrowing nematode and the tolerance of citrus and ornamental nursery stock to water at that temperature.

Several saprophytic genera of nematodes, a species of meadow nematode, and the burrowing nematode were tested in a hot water bath to determine their sensitivity to 122°F.(50°C) at different time exposures. Three tests were made with the saprophytic genera as a general indication of how the burrowing nematode might react. Twenty nematodes were placed in each of six glass vials filled with water. These were exposed for 2, 4, 6, 8, and 10 minutes at 122°F.. One vial of nematodes without treatment served as the check in each test. Several criteria were used to determine death, such as: movement, longevity before disorganization, color of the intestines, stimulation, dissection, and incubation on media containing fungi and bacteria. The composite results of the three tests are summarized in Table I.

TABLE 1. The effect of a hot-water treatment on several genera of saprophytic nematodes.

Time (122° F)	Total Count (60 possible)	Condition of Nematodes Living	Dead	Survival %
0 (Check)	49	44	5	90.0
2 minutes	56	43	13	77.0
4 minutes	39	9	30	23.0
6 minutes	48	0	48	0
8 minutes	46	0	46	0
10 minutes	36	0	36	0

None of the saprophytes survived the 6, 8, or 10 minute exposures. A large number of these saprophytes, including the meadow nematode, were treated at the 10 minute exposure none of which survived. After the saprophytes were treated at different exposures mentioned above they were incubated on potato-dextrose agra on which bacteria and fungi were growing. After approximately a month the nematodes had reproduced to large numbers in the check, 2 and 4 minute treatments. There was no sign of life at the 6, 8, and 10 minute treatments.

A test was made with 50 hand-picked specimens of the burowing nematode contained in each of 6 vials. They were tested by the same method and criteria used for the saprophytes. Table II shows results of this test.

Due to the lack of movement there was some uncertainty about the vital condition of a few specimens exposed at 4, 6, and 8 minutes. They appeared to be dead after the 10 minute exposures by all the criteria used to determine life. To make certain of this a large mixed population of nematodes along with the burrowing nematode was treated for 10 minutes at 122°F., shortly after extraction, while they were still in a more active condition. None survived this treatment. On the basis of this information an hypothesis was formulated to the effect that the temperature exposure required to kill the burrowing nematode under the conditions of these experiments would be approximately the same as that required to kill them in the roots of plants. This hypothesis was tested on infested roots. Six experiments were carried out with infested citrus roots and one with roots of the ginger lily. Most of the tests involved exposures of 6, 8, 10, 12, and 15 minutes at 122°F. The first test was made with 50 gram samples. In the remaining tests 8 gram samples were used with 4 to 8 replications, except one employing ginger lily rots, the samples from which were 3 1/2 ounces with 2 replications. After treatment and incubation the total number of nematodes and their vital condition was recorded at different intervals. Table III shows a summary of the results of 4 of these tests.

TABLE 2. The effect of hot-water treatment on the burrowing nematode in vitro.

Time (122° F.)	Total Count Total Count	Condition of Nematodes Living	Dead	Survival %
Check	40	39	1	97.5
2 minutes	36	35	1	97.2
4 minutes	37	37	0	100.0
6 minutes	37	0	37	0
8 minutes	29	0	29	0
10 minutes	29	0	29	0

It should be pointed out that the roots were washed thoroughly prior to incubation and the nematodes counted at different intervales up to as much as 8 days after treatment. No nematodes appeared in the checks 15 days after treatment. The nematodes observed in the heat-treated root samples were believed to have been present on or near the root surfaces. The fact that no life showed up after 8 days in the heat-treated roots suggests that these heat treatments are ovicidal and larvicidal.

TABLE 3. The effect of hot water on the burrowing nematode in roots.

(122°F) Time	Number of Nematodes	Condition
Check	166	All living
6 minute	13	Few living?
8 minute	16	Life doubtful?
10 minute	30	Dead
12 minute	33	Dead
15 minute	19	Dead

Seedlings of various citrus stocks and bare-rooted croten plants were treated in a hot-water bath at 122°F. (50°C.) for various lengths of time. The temperature was thermostatically controlled and an even circulation of the water maintained. The plants were treated bare rooted after which they were replanted in one-gallon cans and grown in half shade. Ten replications were used in all tests except one in which 8 replications were used.

Five tests were made on rough lemons at exposures varying from two minutes to 3 1/2 hours at 122°F. (50°C.). Not a single plant was killed out of 300 employed in the tests. Moreover no observable dwarfing of the tops or roots was detected in subsequence growth.

Cleopatra seedlings were tested at 1-, 1 1/2- and 2-hour exposures to 122°F. Rather severe defoliation was noted as a result of 1 1/2- and 2-hour exposures and very slight defoliation following the 1- hour exposure. Shorter exposures than 1-hour are probably safe.

Two tests were made with crotons. The first test involved exposures of 2, 4, 6, 8 and 10 minutes at 122°F. without ill effects. The second test involved 15, 20, 25, 30 and 35 minutes exposures at 122°F. The crotons were partly defoliated but survived the treatment. Crotons are sensitive to transplanting bare root, however, and a practical treatment must be developed for potted plants since they can not be readily handled bare root.

CONCLUSIONS

(1) The thermal death point of the burrowing nematode is approximately 10 minutes exposure to 122°F.

under the conditions of these experiments.

(2) The tolerance of rough lemon and Cleopatra citrus seedlings (and crotons) lies safely beyond the 10-minute interval at 122°F. found necessary to kill the nematode.

(3) This information should lend itself to a practical application of hot-water treatment to nursery stock on a commercial scale.

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EFFECT OF METHOD OF TIMING NITROGEN FERTILIZER ON YIELD AND QUALITY ORANGES

(Continued From Page 7)

major reason for this low efficiency.

Our studies indicate that when fertilization is confined to the drier months, in general, neither the timing nor the number of applications of a given annual rate of nitrogen fertilization appreciably affects yield. Similar results have been obtained with deciduous tree fruits in widly different areas. (6,9). It follows that efficiency of nitrogen uptake by Florida citrus is likewise not greatly influnced by timing factors since rate of nitrogen fertilization does affect yield profoundly (11). If susceptibility of nitrogen to leaching were the major hazard affecting efficiency of uptake, one would expect that a given annual amount of nitrogen applied in one dose per year would be appreciably less efficient than when applied in 3 or 6 doses. Our studies indicate that one dose in the fall or spring is at least as efficient as 3 or 6 doses and possibly more efficient under certain conditions. Whether one dose applied in the rainy months of July or August would have been as efficient as a similar treatment in fall or spring was not determined but the inclusion of such a treatment would have been illuminating.

The data of Bitcover and Wander (2) indicate that relatively large quantities of nitrogen can be taken up by healthy citrus roots from a nutrient solution in only a few minutes. Studies reported by Sites (12) indicate that insoluble organic sources of nitrogen, which presumably break down and release nitrates

Table 6. Effect of rate and method of timing nitrogen on some fruit qualities of early oranges. Hamlin Experiment

Nitrogen treatment and statistical indices*	Weight per fruit	Rind thickness	Rind color rating**	Juice content (vol./wt)	Composition of Juice			
					Total sol. solids	Citric acid	Solids acid ratio	Vit.C per 100 ml.
	gm.	mm.		%	%	%		mg.
Fruits harvested Nov. 9, 1948								
Low N	183	—	—	48.0	8.80	0.60	14.7	61
Medium N	182	—	—	48.9	8.76	0.59	14.8	60
All N in fall	177	—	—	49.2	8.90	0.60	14.9	62
Three appl.	189	—	—	47.5	8.69	0.60	14.6	60
L.S.D. at .05	5	—	—	N.S.	0.21	N.S.	N.S.	2
Fruits harvested Nov. 9, 1949								
Low N	210	3.53	—	47.6	7.77	0.66	11.8	62
Medium N	216	3.65	—	49.8	7.74	0.67	11.5	60
All N in fall	218	3.55	—	50.3	7.75	0.65	11.8	61
Three appl.	209	3.64	—	47.8	7.75	0.68	11.4	61
L.S.D. at .05	8	N.S.	—	1.7	N.S.	0.03	0.4	1
Fruits harvested Oct. 13, 1950								
Low N	174	3.21	2.6	52.8	8.44	0.88	9.6	60
Medium N	169	3.17	2.6	54.7	8.62	0.93	9.3	60
All N in fall	173	3.24	3.0	54.7	8.67	0.88	9.8	60
Three appl.	170	3.14	2.2	52.8	8.59	0.93	9.1	60
L.S.D. at .05	5	N.S.	0.2	1.3	0.12	0.03	0.4	N.S.

* L.S.D.-least difference required for significance between the paired means with the odds indicated. N.S. indicates the effect of treatment was not significant.
** Arbitrary color rating estimated visually for each fruit with an index of 0 indicating completely green fruit and 4 indicating about 60 percent yellow coloration.

Table 7. Effect of rate and method of timing nitrogen on composition of non-fruiting spring leaves, Hamlin Experiment

Nitrogen treatment and statistical indices*	Mean wt. per leaf (mg.)	Mean percent in dry matter				
		N	P	K	Ca	Mg
Leaves collected July 8, 1949						
Rates						
Low	323	2.26	0.18	2.00	3.40	0.33
Medium	330	2.41	0.14	1.78	3.43	0.35
Timing						
All in fall	32.2	2.31	0.15	1.80	3.50	0.34
Three appl.	322	2.36	0.17	1.98	3.33	0.35
L.S.D. at .01	N.S.	0.11	0.02	0.11	0.16	N.S.
Leaves collected July 17, 1950						
Rates						
Low	341	2.28	0.16	2.21	3.87	0.38
Medium	353	2.39	0.15	1.93	3.81	0.40
Timing						
All in fall	342	2.34	0.15	2.05	3.87	0.39
Three appl.	351	2.33	0.16	2.09	3.81	0.39
L.S.D. at .01	N.S.	0.10	0.01	0.16	N.S.	N.S.

* L.S.D. at .01-lease difference required for significance between pairs of means with odds of 99 to 1. N.S. indicates the effect of treatment was not significant.

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to the soil gradually, are, if anything, somewhat less efficient than the more readily leached soluble inorganic sources. Still other studies have shown that the effective depth of rooting on the deep sandy soils commonly used for citrus in central Florida is rather great. In mature groves, appreciable moisture extraction occurs at a depth of at least 8 to 10 feet (7) and a functionally significant density of fibrous roots is commonly found below a depth of 10 feet (5).

Thus, much of the available evidence, though indirect, is not altogether concordant with the theory that the low nitrogen efficiency common in Florida groves is mainly due to its susceptibility to leaching. It appears to us that some other factor or factors yet to be discovered are of importance in this connection.

The data presented suggest that healthy citrus trees can, when generously supplied with nitrogen, store enough reserve of this element in leaves, roots and other tissues from one application per year to maintain a high level of yield and productivity. This large nutrient storage capacity of the citrus tree is undoubtably an important factor in the high yields attainable on these very sandy, inherently infertile Florida citrus soils.

The data reported by Sites, et al. (13) concern fertilizer timing experiments using large unreplicated plots of Hamlin oranges. Insofar as can be judged from a comparison of treatments which are not strictly comparable, the lack of strong, consistent effects of timing on fruit quality obtained by them is in agreement with the results of our studies. The yield results obtained suggest that applying a complete fertilizer in two equal amounts in February-March and in May-June produced more fruit over a four-year period than other methods of timing studied. Our studies did not include this interesting timing regime. It would be desirable to study this method of timing further, including treatments that would help to differentiate efforts of nitrogen timing from the timing of other fertilizer elements and using a design which would permit greater precision in comparing treatments.

Conclusions

Data obtained during the past seven years from three field experiments in central Florida groves of orange trees on Rough lemon stock planted on deep, well-drained soil of the Lakeland or related series indicate that, in general, neither the time of application nor the number of applications of a given adequate annual

(Continued to page 19)

Jack Hooten, Hooten Grove Service, Clermont, checks on his 1,000 box per acre yield in a d/p DOLOMITE soil-conditioned grove.

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Copper Oxide As A Soil Amendment For Citrus

DR. HERMAN J. REITZ AND
NEIL F. SHIMP
FLORIDA CITRUS EXPERIMENT
STATION, LAKE ALFRED

Practically all of the copper used in Florida citrus fertilizer has been in the water-soluble copper sulfate form. Recently a product containing a mixture of cupric and cuprous oxides, in which the copper is only slightly water soluble, has been offered for use in citrus fertilizers. The availability to plants of this form of copper already has been demonstrated for other crops on peat soils (1) but its value for citrus on mineral soils has not been demonstrated heretofore.

Most of the doubt concerning the availability of copper in oxide form centers around its low water solubility. While water solubility is a characteristic possessed by most fertilizer materials in use at present, a high degree of water solubility has not proved essential for availability of copper to plants. Numerous references can be found in the literature which describe the successful use of relatively insoluble compounds to overcome copper deficiency. Some of these have been copper refinery slag (6); oxidized copper ore, roaster residues from pyrite burners (9); copper pyrophosphate catalysts, tetra copper calcium oxychloride, copper hydroxide, metallic copper (2); and minerals such as chalcopyrite, chalcocite, cuprite, and malachite (8). Trials were run with these materials in some cases on organic and in other cases with mineral soils. In view of facts such as these, Steenbjerg (8) has proposed the theory that the availability of copper in any compound depends upon the copper content of the compound and on the fineness of grinding, that is, the surface exposed. This theory involves solubility only indirectly.

In addition to demonstrations that the copper in some insoluble compounds is available to plants, there is the consideration that even water soluble forms of copper become fixed in insoluble forms in the soil. According to Lucus (5), copper applied as copper sulfate to peat soils is precipitated as the hydroxide if the pH is above 4.7. It appears more generally believed that copper is fixed in combination with the soil organic matter in Florida (4).

With this background it appeared probable that finely divided copper oxide would be available to citrus unless, for some unexpected reason, the combination of citrus plants and Florida soils would prove to be an exception.

In order to determine the relative availability to citrus of copper from oxide, comparisons with copper sulfate were undertaken, both in the field and in pot cultures. Field trials established in young groves have so far been inconclusive because of failure to develop more than traces of copper deficiency under any conditions. Pot studies carried out in 1951 and 1952 have provided some information, which will be presented in this paper. Two general types of pot experiments were conducted. In one relatively low soil copper conditions were established to determine comparative citrus seedling growth and copper uptake from copper sulfate and copper oxide. This was simply an attempt to demonstrate possible increased growth and copper content of plant tissues due to copper additions from the two sources. In the other, relative toxicity of equal high soil concentrate of copper from the two sources was determined. This experiment was undertaken simultaneously with the low copper experiment, since it was believed that with soil cultures, difficulty might be experienced in obtaining a differential due to copper deficiency. Development of copper toxicity might then provide an approximately, indirect measure of availability in the soil of copper applied in the two forms.

METHODS

Large bulk samples of the surface layers of previously uncultivated soils of Lakeland, Ft. Meade, and Parkwood series were obtained, and each was mixed thoroughly. Some characteristics of the soils used are given in Table 1. The soil used in each pot was weighed out into a small concrete mixer, the proper amount and form of copper was added, and the lot then mixed thoroughly. The copper sulfate used was sugar-sized crystals and the oxide was a very fine powder. Ten-inch clay pots were used in all experiments.

For the low copper series, sour orange, rough lemon, and Cleopatra mandarin seedlings were started in sand culture without adding copper. These seedlings were transplanted into the soil culture when 3 to 4 inches high. Treatments, in addition to a no-copper check, included each source of copper used at 9.5 or 10 ppm., and 47.5 or 50.0 ppm. metallic copper. Seedlings in the Lakeland series grew fifteen months outdoors except during mid-winter while seedlings in the Ft. Meade and Parkwood series grew outdoors nine months.

Seedlings for the high copper series were planted in ordinary grove soil and transplanted into treatment pots when 4 to 5 inches tall. Sour orange and Cleopatra mandarin seedlings were used with Lakeland and Ft. Meade soils, but only Cleopatra mandarin was used with the Parkwood soil. Concentrations of copper added to the soil ranged from 0 to 1000 ppm. Each combination representing a different soil, seedling type, or copper level was duplicated with copper oxide and copper sulfate. After mixing the copper compounds with the soil, the pots were allowed to stand in the open in moist condition for six weeks. Seedlings were transplanted in March, 1952, and the trials were terminated in December, 1952. All pots were at first fertilized per-

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lodically with mixtures of pure chemicals containing most essential elements except copper, but later only sodium nitrate was applied.

RESULTS

Low Copper Series. The plants in the Lakeland soil in July, 1952, had grown ten and one-half months. The sour orange and Cleopatra at this time appeared to show some increase in growth due to the 9.5 ppm. copper treatment and a smaller increase in growth at the 47.5 ppm. rate. Consequently in July, 1952, the tops of these plants were removed, the leaves were washed with an acidified solution of detergent, dry weights of the tops were obtained, and copper contents of the leaves were determined. The data obtained in this preliminary sampling were very similar to those obtained at the end of the experiment and hence are not presented here. These plants were allowed to grow new tops, and data presented below concern only the second growth of tops on these plants.

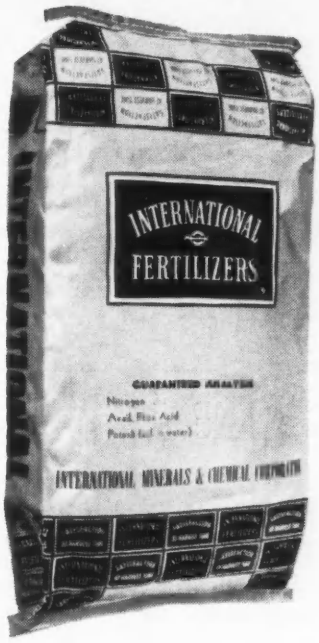
Table 1. — Soil Characteristics of Soils Used in Pot Experiments

Soil Characteristic	Soil Series		
	Lakeland Ft. Meade		Parkwood
Original pH	5.6	5.1	8.0
Natural Cu Content, ppm	4.5	2.0	5.1
Organic Matter, percent	1.21	3.33	4.11
Carbonates, perct.	—	—	15.3
Total Phosphorus, ppm P	135.	52.	69.

The experiment was terminated in December, 1952. At this time, the leaves were removed from the plants, washed in acidified detergent solution, dried, weighed and analyzed for copper. Stems and roots were washed free of soil, dried and weighed. Average results for the replications of each treatment are given in Table 2.

On all soils growth was usually slightly increased by the 9.5 or ppm. rate of copper application. While similar trends were evident on all soils, the growth was of statistical significancy only on the Ft. Meade soil, which had the lowest natural copper content.

Increase in copper application to 47.5 or 50 ppm did not result in greater growth than at the lower rate. In fact, some plants grew less than those in the no-copper pots. This slight restriction of growth at the higher rate may have been a mild expression of copper toxicity. No iron chlorosis was observed in any of these seedlings during the experimental period. Plants in soil treated with copper oxide were usually slightly larger than those in soil treated with copper sulfate, but the difference



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due to source was not statistically significant.

Copper content of leaves was very low in some individual cases, but no copper deficiency symptoms aside from restricted growth were observed. Copper content of leaves was significantly increased by the 9.5 or 10.0 ppm rates, and except in Cleopatra, somewhat further increased by the application of 47.5 or 50 ppm. The two sources of copper produced nearly identical copper content of leaves.

It is believed that this experiment demonstrated the adequate availability to citrus of copper applied in oxide form at low soil copper levels.

High copper series. In the Lakeland soil series, observable effects of the high copper levels appeared within a few weeks and became accentuated as time went on. At the end of the experimental period some restriction in growth of the sour orange seedlings had occurred at 100 ppm copper, but no restriction in growth of Cleopatra mandarin had occurred. Growth at higher levels was progressively reduced by increasing copper concentrations up to about 350 ppm and above this level little or no growth occurred. No leaf symptoms of any type developed on the plants in the no copper treatment. At 100 ppm copper, very slight yellowing of the foliage was observed. At 250 ppm copper and above, the leaves of most plants turned yellow soon after planting, and thereafter appeared as though affected by drought and nitrogen deficiency. Some iron chlorosis developed at 250 to 500 ppm copper, practicularly in Cleopatra seedlings. As time went on, the plants at the highest copper levels became partially defoliated from the base upward.

While the severe toxic effects described above were occurring, only minor differences due to copper source appeared. At the beginning of the experiment, several plants at the higher levels in the sulfate series died, but few plants died in the oxide series. This difference presumably is due to temporary residual soluble copper from the sulfate source. Toward the end of the experiment no difference appeared to exist between the two copper sources.

Growth and development of symptoms in the corresponding plants in Ft. Meade soil was generally similar to that in Lakeland soil, except that slightly higher copper levels were required to produce equal effects. Growth was not obviously affected by 100 ppm of copper but generally severely retarded by 250 ppm copper and over. Leaf color was usually dark green at 0 and 100 ppm, pale green at 250 ppm and generally yellow at 350 ppm and over. Iron chlorosis was produced in Cleopatra by copper oxide at 100 to 350 ppm and by copper sulfate at 250 to 750 ppm. Iron chlorosis was appreciably less common in sour orange seedlings than in Cleopatra. Yellowing, wilting, and sometimes basal defoliation were prominent at 500 ppm and over.

Sources of copper made little difference in the results except that, as in the Lakeland series, several plants died in the high copper sulfate

Table 2
Growth and Copper Content of Citrus Seedlings in the Low Copper Series, Treated with Equal Amounts of Copper From Two Sources

Soil Type	Copper Source	Copper Added ppm	Cleopatra		Sour Orange		Rough Lemon		Av. all species	
			Dry Weight gm/plant	ppm Cu in Leaves	Dry Weight gm/plant	ppm Cu in Leaves	Dry Weight gm/plant	ppm Cu in Leaves	Dry Weight gm/plant	ppm Cu in Leaves
Lakeland	—	0	13.3	6.3	17.8	4.1	10.2	12.8	13.8	7.7
	CuO	9.5	15.8	8.8	19.5	12.4	11.6	15.2	15.6	12.1
	CuSO4	9.5	14.0	8.0	16.4	11.6	9.8	15.5	13.4	11.7
	CuO	47.5	11.8	8.0	21.4	19.2	9.8	21.6	14.3	16.3
	CuSO4	47.5	14.0	9.5	14.7	17.7	9.2	18.1	12.6	15.1
	LSD*								NS	3.9
Ft. Meade	—	0	3.2	4.7	7.6	5.2	6.1	9.3	5.6	6.4
	CuO	10.0	6.6	8.8	11.7	14.3	8.9	13.3	9.1	12.1
	CuSO4	10.0	6.4	8.3	11.5	13.4	9.0	12.8	9.0	11.5
	CuO	50.0	8.0	8.5	10.7	17.6	7.1	15.6	8.6	13.9
	CuSO4	50.0	5.7	11.6	9.3	16.8	8.6	16.1	7.9	14.8
	LSD*								2.6	2.6
Parkwood	—	0	3.6	5.0	10.3	5.1	7.1	10.3	7.0	6.8
	CuO	10.0	4.2	10.0	15.3	11.9	7.5	15.6	9.0	12.5
	CuSO4	10.0	3.9	9.8	12.2	12.2	7.6	14.0	7.9	12.0
	CuO	50.0	4.7	11.0	12.1	17.6	8.6	16.8	8.5	15.1
	CuSO4	50.0	3.7	11.2	7.9	19.2	9.4	17.7	7.0	16.0
	LSD*								NS	1.6
Avg. - All Soils	—	0	6.7	5.3	11.9	4.8	7.8	10.8	8.8	7.0
	CuO	10.0	8.9	9.2	15.5	12.9	9.3	14.7	11.2	12.2
	CuSO4	10.0	8.1	8.7	13.4	12.4	8.8	14.1	10.1	11.7
	CuO	50.0	8.2	9.2	14.7	18.1	8.5	18.0	10.5	15.1
	CuSO4	50.0	7.8	10.8	10.6	17.9	9.1	17.3	9.2	15.3

LSD - Least significant difference at 5% level.
NS - Nonsignificant.

Table 3
Growth and Copper Content of Citrus Seedlings in the Copper Toxicity Experiments

Form of Copper	ppm Cu Added to soil	Lakeland				Ft. Meade				Parkwood	
		Sour		Cleopatra		Sour		Cleopatra		Cleopatra	
		Dry Weight gm/plant	ppm Cu in Leaves	Dry Weight gm/plant	ppm Cu in Leaves	Dry Weight gm/plant	ppm Cu in Leaves	Dry Weight gm/plant	ppm Cu in Leaves	Dry Weight gm/plant	ppm Cu in Leaves
CuSO4	0	23.2	16.6	8.5	10.7	27.0	9.7	12.2	8.5	19.9	3.1
	100	7.8	25.6	8.9	12.7	21.9	30.7	14.0	17.4	19.0	6.3
	250	2.3	39.3	4.1	19.0	10.9	27.5	10.3	19.6	17.6	7.9
	350	1.8	46.6	1.7	36.8	3.9	43.2	6.3	35.0	18.4	7.6
	500	2.0	49.8	3.5	23.0	3.8	41.7	4.7	22.2	17.6	10.0
	600	*	*	2.0	37.6	2.1	28.1	2.3	33.3	15.6	9.6
	750	*	*	2.0	47.5	3.7	40.1	3.9	26.5	16.4	10.1
	850	2.5	57.2	2.2	22.2	*	*	*	*	13.6	9.2
	1000	2.3	72.6	1.5	55.8	*	*	*	*	13.7	12.9
CuO	0	20.0	12.5	7.7	9.3	15.6	14.3	16.1	9.0	15.7	4.0
	100	13.7	25.8	13.2	11.8	22.2	26.7	20.3	19.1	19.2	8.3
	250	4.8	34.8	3.7	21.9	19.9	36.1	8.9	25.9	19.5	9.2
	350	2.8	38.0	1.5	46.8	10.2	38.0	4.4	28.2	11.7	12.5
	500	1.8	34.6	2.2	34.6	3.4	48.6	2.5	30.1	10.1	10.1
	600	1.7	31.4	1.4	39.6	0.5	33.3	0.8	37.1	7.1	13.1
	750	2.1	55.4	2.0	43.0	0.7	36.7	1.6	33.4	12.9	11.2
	850	1.6	46.2	2.4	43.4	2.0	33.2	1.4	42.6	6.9	26.1
	1000	1.6	50.8	1.8	44.1	1.9	31.2	5.1	33.0	10.0	11.8

* All plants in these pots died in the early stages of the experiment.

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series at the beginning of the trial, and as noted above, some difference appeared in the occurrance of iron chlorosis.

On Parkwood soil only Cleopatra mandarin seedlings were used. For the first three months of the trial these plants grew slowly and no difference appeared. At the end of this period considerable growth occurred at the lower copper levels and noticeable less growth occurred at the higher levels. No yellowing, wilting or basal defoliation was observed in any part of this series.

Where copper sulfate was the source of copper, growth was moderately but regularly reduced by increasing amounts of copper in the soil. No iron chlorosis was observed at any time in this series. Where copper oxide was the copper source, growth was fairly good up to 500 ppm copper, but was reduced at this level and above. At all copper levels higher than 500 ppm severe and persistent iron chlorosis symptoms developed on all plants, greatly retarding growth. Thus copper from oxide appeared to be more toxic than copper from sulfate in the Parkwood soil. Possibly this difference was due to the more uniform mixing of the finely divided oxide throughout the soil, so that everywhere roots came in contact with toxic copper concentrations.

The toxicity experiment was terminated on December 8, 1952, at which time all the symptoms described above were present. Average weights of the plants in these series of pots are given in Table 3. These data support the observations presented above, indicating that copper supplied as oxide is generally as toxic as copper supplied as sulfate, and hence, as available.

Copper contents of the leaves of these plants are given in Table 3. Few of the values presented are low, partly at least because the seedlings were started in ordinary grove soil, moderately high in copper. In Lakeland and Ft. Meade soils, extremely high values were found associated with plants which were severly stunted by copper toxicity. In spite of the washing procedure it is difficult to believe that in the case of severely stunded plants the copper analysis represented internal leaf copper. Under nutrient solution conditions where contamination presumably was under better control, high leaf copper contents have not been obtained (7).

It is more likely that the high leaf copper contents are due in considerable part to contamination with high

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copper soil through splash erosion of the coarse textured soil by raindrops over all the leaf surface of the smaller plants. It is the senior author's experience that leaves contaminted by copper-containing residues cannot be washed in any way to completely differentiate between surface residues and internal leaf copper. In addition, some of the copper found in these samples may have been absorbed through the leaves. In the finer textured Parkwood soil, less splash erosion of soil occurs than in the sandier soils. Also, the plants in Parkwood soil were much taller throughout the higher copper levels, thus reducing the chance for contamination from this source. Therefore, only the copper data for Cleopatra on Parkwood soil and for the lower copper levels in the acid sands seem reliable.

Copper content of leaves of Cleopatra mandarian seedlings in Parkwood soil was relatively low and did not increase consistently with soil copper concentrations above 350 to 500 ppm. Apparently copper is not translocated into leaves of Cleopatria as readily as into sour orange and rough lemon. Also the toxicity of any soil copper level was very much lower in this soil than in the acid sands. Leaf copper values are slightly higher with copper oxide than with sulfate, indirectly indicating at least equal availability of copper from the oxide.

DISCUSSION

Since the results presented above indicate that copper applied as either sulfate or oxide is approximately equal in effect, a high degree of water solubility apparently is not an essential characteristic of copper sources for soil amendments. On the basis of the experiments described above it appears reasonable to believe that copper oxide can be expected to prevent the occurrence of copper deficiency in groves if used in amounts equivalent in metallic copper content to amounts recommended for the sulfur. This should be regarded as a tentative recommendation pending the outcome of field trails now in progress.

In view of the recent interest in copper induced iron chlorosis, it may be useful to point out that iron chlorosis is only one phase of plant behavior in relation to copper supply. In the plants described here, a range of symptoms from slight deficiency to extreme toxicity was observed. Extreme deficiency symptoms (as exanthema, gum pockets, and dieback (3)) were not observed, but at slight deficiency levels, sub-optimum growth occurred. Also, at only slight toxic copper levels, the first symptom was reduced growth. This effect may well be injurious in the field but difficult to detect. Iron chlorosis appeared at higher levels, sometimes only transiently, together with still further reduced growth. Finally at even more highly toxic levels, growth was completely arrested, and general yellowing of foliage was induced. This series of symptoms reemphasizes the fact that copper-induced iron chlorosis appears after some decrease in growth already has occurred. While copper-induced iron chlorosis rightfully deserves study, another general need is an accurate criterion to use in determining whether groves have proper copper supplies for optimum growth of both tops and roots.

SUMMARY

Relative availability and toxicity to citrus seedlings of copper supplied as oxide or sulfate was studied in pots of Lakeland, Ft. Meade, and Parkwood soils. Soil copper levels ranged from less than 5 ppm to 1000 ppm.

With previously uncultivated soils, copper additions of 9.5 or 10 ppm copper slightly increased seedling growth, and increased copper content of leaves significantly. Differences due to source were minor and not statistically significant.

Generally at high copper levels the oxide and sulfate forms were about equally toxic. However, the sulfate form was somewhat more toxic on acid sands in early stages of the experiment, presumably due to temporary residues of soluble. Copper oxide was more toxic in Parkwood soil, possibly because of more uniform

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distribution of the finer particles throughout the soil.

Cleopatra mandarin showed iron chlorosis more commonly than did sour orange and accumulated less copper in leaves than did sour orange and rough lemon.

Soil toxicity level of copper was demonstrated to be slightly higher for Ft. Meade than for Lakeland, and much higher for Parkwood.

Copper oxide can be tentatively recommended as a soil amendment for citrus, and may be used at rates equivalent in metallic copper to those recommended for copper sulfate.

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EFFECT OF METHOD OF TIMING NITROGEN FERTILIZERS ON YIELD AND QUALITY ORANGES

(Continued from page 13)

rate of nitrogen fertilization profoundly affects yield or tree vigor. Applying the annual dosage of nitrogen to bearing trees in one application in October or in March was as effective as applying it in 3 equal doses in the conventional manner, or in 6 equal doses every 2 months. It should not be concluded from these studies that a single application of an adequate amount of mixed fertilizer containing the other required elements in addition to nitrogen would give results as satisfactory as the same dose divided among two or three applications. To date, our experimental evidence on this point is inadequate to draw conclusions. It is conceivable that such a heavy dose of mixed fertilizer applied at one time might, under certain conditions, in sandy soil, damage fibrous roots because of a temporary high salt concentration. Thus, there appears to be no economy reason to confine the application of nitrogen to one dose, since it is likely that at least two applications of some sort of fertilizer materials will be required to supply the annual requirements with safety anyway.

In general, the effect of nitrogen timing on fruit quality was not large or consistent enough to be of much practical significance. However, with the Hamlin variety, applying the annual supply of nitrogen in one dose in the fall produced fruit of slightly higher juice content and earlier maturity than splitting the annual supply into three doses.

The data obtained to date do not indicate any compelling reason to modify currently popular timing practices for groves on deep, well-drained, sandy soil. They do suggest, however, that a great deal of flexibility is possible in the number and timing of nitrogen applications in the drier period from October 15 to June 15. The experiments did not include tests of heavy applications of nitrogen in the rainy period from June 16 to October 15.

(Continued to page 22)

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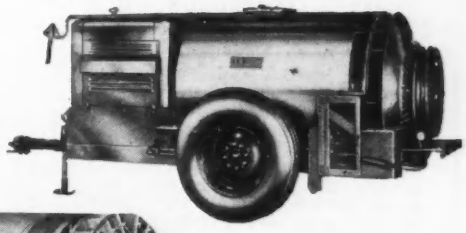

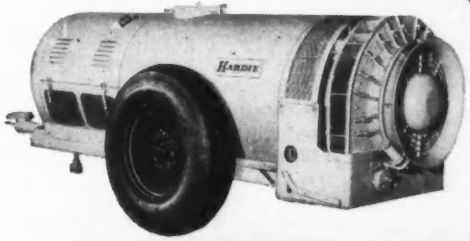

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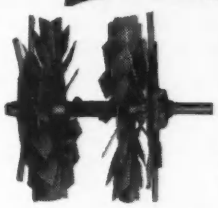

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Most early and mid-season oranges have been moved—Valencia oranges may hit the jack pot as they range from $1.85 to $2.00 at this time and no doubt will go somewhat higher. I talked to a grower the other day who has large acreage, a chap who generally inclines toward the conservative side, and he informed me it was his opinion that late Valencias may go to $3.00. I do hope he is right.

There has been plenty of scale, rust mite, and six spotted mite, in evidence around the groves. However, the recent rains have somewhat retarded them.

Growers have been spraying in most sections and a good bloom is on the way. It begins to look like there is a good crop in the making for the coming harvest, barring bad luck with any of the several things that could happen.

SOUTHWEST FLORIDA

Eaves Allison

Citrus came through the hard freeze on Feb. 11th and 12th with no damage in this area to fruit, bloom or new growth. A close call! Prices are on the rise and the growers are breathing easier. Leaf drop has been severe in this section, caused by damage from the Spider Mites, with considerable help from that old stand-by our friend the rust mite. If it were not for all these friendly pests and other difficulties good citrus would sure be cheap!

The tomato plants in Ruskin-Palmetto area spring field plantings had severe cold damage—from 20% to 90%—with an average of somewhere around 50% killed. Some plantings that had not been thinned came through with limited kill and will furnish replants for a part of the lost acreage.

Cukes were practically all killed and re-seeding was done at once. Watermelons came off better with about 30% killed, probably resulting in a reduced acreage being harvested, as this date is too late for re-seeding in this area.

That good Lyons fertilizer will start everything back to growing again.

HIGHLANDS AND POLK

J. K. Enzor, Jr. & R. E. Lassiter, Jr.

By the middle of February most growers in this area have completed their spring top dresser application.

A great majority of the groves have begun to bloom and new growth has appeared in all cases.

The cold weather experienced on February 12th and 13th apparently caused very little damage to citrus in this section. However, considerable scattered damage has been noted throughout this area from cold weather experienced in January.

Purple mites have been observed in many groves where the spring flush is far enough along that it is dangerious to use DN in these cases. Aramite or Ovex should be used.

It will soon be time for the 1955 young tree fertilizer program to begin. As soon as the banks have been pulled down young trees should receive their first fertilizer application.

Rainfall has been very satisfactory in this area, although we have not had any excessive amount, we have had good soil moisture in most groves throughout the winter.

NORTH CENTRAL FLORIDA

V. E. Bourland

We had a very nice rain here Thursday night and Friday, and have had high, cold wind since which has kept things from freezing as was reported by the weather bureau. Most growers were very busy banking young trees, and others that were prepared to fire groves, had help standing by watching the thermometer, but little firing was done through this section. Most of the midseason fruit has been sold or contracted, and majority of it has already been picked. Grapefruit is still going slow with still a lot to move, but price is the reason for this. Most all the vegetables and melons have been whipped by the cold wind and sand until the prospect is very poor, and the majority will have to be replanted.

SOUTH POLK, HIGHLANDS, HARDEE AND DESOTO COUNTIES

C. R. Wingfield

Low temperatures, frost and cold winds through mid-February brought much damage and complete destruction to most tender vegetable crops in this section. Many pounds of seed have failed to germinate and rotted in the cold ground. The low predicted temperatures did not occur on February 12th and 13th but the cold winds were bad enough.

Citrus came through with very little actual damage with the exception of a little burned foliage. There has been an unusual leaf drop which no doubt has been agitated by the cold winds. In spite of all the cold we have had the blooms ready to break forth and with a few days of good weather the tree will be white with bloom. Moisture conditions are good and the Top Dressers are being applied. Young trees will be fed soon if there is no signs of another cold spell.

NORTH HILLSBOROUGH AND PINELLAS COUNTIES

J. A. Hoffman

Some growers in this section have already started applying a top dresser, but due to all the cold weather the majority are holding off until the last of February or early March before fertilizing and cultivating. A high Nitrogeon-Potash mixture will be used in most groves.

The cold spell during the early part of February did very little damage to Citrus. All watermelon minor scorching of leaves on young trees. Some growers fired on the morning of February 13th when the temperature fell to 29 degrees by 1:30 a. m. Strong winds later on in the morning would have accounted for the minor amount of damage to citrus other than some plants were killed, but most growers had another planting of seed in the ground which are now coming through in good shape.

The marketing of citrus fruits has picked up the past few weeks with much better prices being offered for all varieties than during January.

XUM

ADVERTISEMENT — LYONS FERTILIZER COMPANY

Uncle Bill Says:

We ain't forecasting the weather for the next thirty days 'though we are inclined to think that any real threat of winter is rapidly passing . . . but we want to say one thing we were sure plum lucky earlier this month when the fellers who forecast the weather, very properly, had most of us growers scared almost out of our shirts.

It got plenty cold alright, but the wind 'er whatever it was kept us from windin' up with a lot of frozen fruit and trees . . . maybe its 'cause us citrus growers live right, or been payin' the preacher regularly, but whatever the reason every single one of us has got plenty to be thankful fer.

'Course some of us had figured if they was a bad freeze and our grove happened to escape damage we'd git a mighty big price fer what was left of our fruit, but that's sort of a selfish way to look at things . . . personally, we're mighty glad that nobody really got hurt bad durin' this cold spell, even if our fruit prices ain't quite as high as we'd like 'em to be.

Seems, too, like our trees can stand more bad weather then they used to . . . and we suspect the real answer lies in the fact that most folks is feedin' their trees enough real nourishment to make 'em strong and healthy enough to stand up against cold, and insects, and windy weather . . . which is one reason we ought to be grateful that fertilizer folks and other production experts is improvin' their products right along so that we can profit by the new things they are learnin' about this big industry of Florida.

Which leads us to remark again that business of growin' Florida citrus fruit based on the standpoint of returns on the investment is a pretty good business . . . if you don't think so compare your earnin's per dollar invested with any merchant whose invested capital is approximately the same as yours.

XUM

Some Florida Farm Statistics

According to the U. S. Census of 1950, there are 34.7 million acres of land in Florida. Of this amount nearly 48 percent was in farms or approximately 16.5 million acres. This represents a 3.4 million acre increase during the five-year period from 1945. This increase was mainly in pasture land. There were close to 57,000 farms in the State at the time of the 1950 Census. Of the 16.5 million acres on Florida farms less than 21 percent was in cropland, the remainder being in pastures, woodland pastures and other woodland. Land on which Florida's large assortment of 39 different crops were grown in 1953 totaled a little more than 2.4 million acres, or about 67,000 acres more than the plantings in 1952.

According to the 1950 Census the total population of Florida was 2,771,305, of which 1,813,890 or 65.5 percent were urban and 957,415 or 34.5 percent were rural. Ranking 20th among the States according to population Florida moved up from the 27th position during the period from 1940 to 1950. During this decade Florida's population increased by 873,891 which placed Florida third in percent increase with 46.1 percent and Arizona in percent increase in and was exceeded only by California population.

Field crops in north and northwest Florida made fair progress during July despite above normal temperature which was offset to some degree by local showers which gave about normal precipitation in most areas. Cotton, corn, peanuts and tobacco are expected to produce above normal yields. Temperature in central and south Florida was normal to slightly below normal most of the month. Above normal rainfall occurred in most of the south and central portions of the State.

Cotton picking got under way a little earlier than normal this season. The 1954 cotton crop is estimated at 18,000 bales. This is a 33 percent decrease from production in 1953. Total acreage of cotton for harvest as of August 1 was 40,200 acres as compared with 71,000 acres in 1953 or a 43 percent decrease. The average lint per acre is estimated at 215 pounds which is 33 pounds or 18 percent more than yield for 1953.

Florida's 1954 corn crop is estimated at 9,686,000 bushels, about 2 percent smaller than last year's crop of 9,884,000 bushels. Yields are now expected to average 16.5 bushels which is the same as last year. Florida's at production shows a decrease with the current estimate of 1,080,000 bushels compared with last year's crop of 1,200,000 bushels. This year's oat yield per acre is estimated at 30 bushels per acre, the same as last year. The production of flue-cured tobacco, Type 14, is indicated at 24,182,000 pounds which is almost 7 percent more than last year's crop of 22,684,000 pounds. This year's expected yield is 1,130 pounds per acre and compares with 1,070 pounds last year. The shade tobacco crop, Type 62, in Georgia and Florida is estimated at 5,969,000 pounds compared with 4,498,000 pounds last year. The acreage of peanuts for picking and threshing is estimated at 54,000 acres for 1954. This is a reduction from last year of 2,000 acres or 4 percent. This year's yield is estimated at 900 pounds per acre which compares with 975 pounds last year.

The value of crops harvested in Florida increased about $13 million, as higher return for citrus and nuts more than offset lower returns for vegetables and field crops. The value of all crops harvested in 1952-53 is placed at $371.3 million, 3.7 percent more than the 1951-52 return of $358 million. A breakdown in valuation shows that fruits and nuts accounted for nearly $169 million, vegetables close to $142 million and field crops $61 million. Livestock and poultry production showed a gross income of almost $135.5 million. This makes a total valuation of crop and livestock production of Florida farms for the 1952-53 season of approximately $506.9 million, as compared with $494.2 million for 1952 or an increase of $12.6 million, or over 2.5 percent.

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EFFECT OF METHOD OF TIMING NITROGEN FERTILIZERS ON YIELD AND QUALITY ORANGES

(Continued from page 19)

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Most retired people get their income from more than one source, but relatively few supplement their income by working, according to a contributor to the University if Florida Press book "Living in the Later Years."

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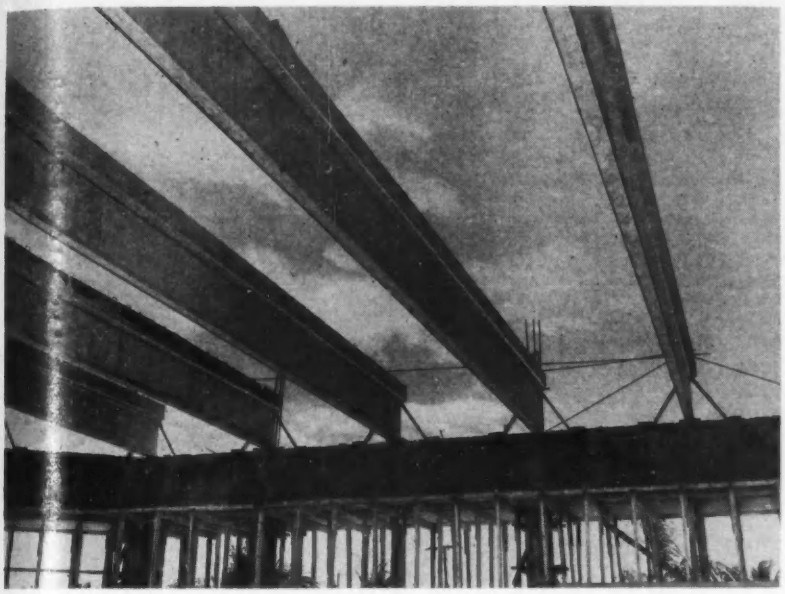

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